A NEW METHOD TO PRODUCE AORTIC ANEURYSMS IN RABBITS BY EXPERIMENTALLY RESTRICTING THEIR MOVEMENT

W. W. Tjawokin

Translation of "Ueber eine neue Methode der Erzeugung von Aortenaneurysmata durch experimentelle Bewegungseinschraenkung bei Kaninchen," *Virchows Arch. Abt. A Path. Anat.*, Vol. 351, 1970, pp. 340-346.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C. 20546 MARCH 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F-15,394	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A NEW METHOD TO PRODUCE AORTIC ANEURYSMS IN RABBITS BY EXPERIMENTALLY RESTRICTING THEIR MOVEMENT		5. Report Date MARCH 1974 6. Performing Organization Code
7. Author(s) W. W. Tjawokin		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address Techtran Corporation P.O. Box 729, Glen Burnie, Md. 21061		11. Contract or Grant No. NASW-2485 13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes
Translation of "Ueber eine neue Methode der Erzeugung von Aortenaneurysmata durch experimentelle Bewegungseinschraenkung bei Kaninchen," *Virchows Arch. Abt. A Path. Anat.*, Vol. 351, 1970, pp. 340-346.

16. Abstract

The thoracic aortas of 12 male chinchilla rabbits were constricted to various degrees by ligatures and the animals subjected to varying degrees of immobility confinement to investigate the question as to whether these factors contribute to the development of aortic aneurysms. Studies indicate the development of aortic aneurysms depends on the degree of restriction of movement, and the degree of constriction of the aorta by the ligature.

17. Key Words (Selected by Author(s))	18

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	6	

NASA-HQ

A NEW METHOD TO PRODUCE AORTIC ANEURYSMS IN RABBITS BY EXPERIMENTALLY RESTRICTING THEIR MOVEMENT[1]

V. V. Tjawokin[2]

As we reported earlier (1965, 1966, 1967, 1969), experimentally restricting the movement of rabbits can produce substantial alterations in the form of arteriosclerotic ulcerations, aneurysmatic constriction of vascular clearance and aortic and myocardic necroses. By varying the duration of the limitation of movement of rabbits, one can produce a coronary insufficiency without arteriosclerosis on the one hand, and in the case of experiments of longer duration, a coronary insufficiency with arteriosclerosis. /340* /341

A coronary insufficiency without arteriosclerosis occurs mostly in the case of short duration (3-5 days) and severe limitation of movement of the animals. Severe limitation of movement of rabbits of longer duration, on the other hand, produces a coronary insufficiency with arteriosclerosis. Since the animals die too soon when severely limited for long periods we induced the coronary insufficiency with arteriosclerosis by limiting the animals first severely, then moderately, and lastly not at all.

In the described experiments the essential alterations develop in the heart and the arteries; the rest of the organism is affected as well, however. The cooperation of the disturbances in the general organism with the local changes causes the preeminence of damage to the heart muscles and the arterial walls. We consider among the disturbances in the general organism the consequences of a drop in the function of the sympathico-adrenergic system and the

---

[1]Report on 19 January 1970 at a meeting of the Leningrad Cardiological Society.

[2]Director of Hospital Therapeutics of the Medical Institute for Pediatrics in Leningrad and K. M. Bykow-Department for General Physiology of the Research Institute for Experimental Medicine of the Academy of Medical Sciences of the USSR, Leningrad. Submitted 21 May 1970.

*Numbers in the margin indicate pagination in the foreign text.

adrenal cortex, which are manifest in displacements in the metabolism of fats, albumin, carbohydrates and minerals. Edema and accumulation in the arterial wall are among the local changes and are an early symptom of arteriosclerosis.

The most severe change which one can achieve by limiting the movement of rabbits is the development of an aortic aneurysm.

Since in the experiments the aortic aneurysm always occurred directly alongside the diaphragm, we were prompted to look for the reason.

We have observed that in rabbits the diameter of the aortic passage through the diaphragm (hiatus aorticus) is relatively small; moreover, the musculature of the diaphragm is predominantly interlaced with the aorta, thus impeding the separation of the aorta from the diaphragm during the experiment.

We hypothesized that the development of the aortic aneurysm at this point is caused by the phrenetic constriction.

Material and Method

To prove this hypothesis, we arranged the following experiment: 12 male chinchilla rabbits divided into five groups were the experimental animals. A ligature of the thoracic aorta was performed on all the rabbits. In the first group (2 rabbits) the diameter of the aorta was not influenced by the ligature. In the second group (2 rabbits) the aortic passage was moderately constricted; in the third group (2 rabbits) the aortic lumen was severely restricted by the ligature. One month after the operation, to produce the severe limitation of movement, these three groups of rabbits were placed in a cage we developed for this purpose (1966). Two months after the operation the animals were decapitated and we proceeded with the macroscopic and microscopic evaluation of the aortic and myocardial changes.

The experimental arrangement and the evaluation of the fourth group (3 rabbits) corresponded to that of the second group except that instead of a severe limitation of movement, the animals were subjected to a moderate limitation. The fifth experimental group (3 rabbits) was kept in conventional cages, and thus not limited in their mobility, but otherwise subject to the conditions of the third group.

The arterial pressure and the pressure in the total aorta were measured before the animals were killed.

Results

The table shows details regarding nature and extent of changes of the aorta and the arterial blood pressure values. /344

Both animals of the first group developed a fusiform aneurysm under the ligature (Figure 1a).

The same thing occurred with the one animal of the second experimental group, while the second animal developed a pouchlike aneurysm above and below the ligature (Figure 1b). /345

One of the animals of the third group developed a pouchlike aneurysm under the ligature and a diffused aneurysm under it (Figure 1c). The second animal of this group died ten days after the start of the limitation of movement. Upon opening the animal we found a large annular aortic aneurysm with a fissure and a massive hematothorax (Figure 1d). The animals of the fourth group did not develop an aneurysm.

In the fifth group, only one animal developed an insignificant expansion of the aorta above and below the ligature (Figure 1e).

Discussion

The experimental results confirmed our assumption that aortic aneurysms can develop under and over a ligature. On the basis of the results, particularly of the first group, one can formulate the developmental mechanism of an aortic aneurysm under a ligature, or, as the case may be, under the diaphragm, in the case of limitation of the movement of rabbits in the following manner:

The rather severe limitation of movement of the animals produces an edema and an accumulation in the aortic wall along with an enlargement of the aortic diameter and a relative constriction of the hiatus aorticus, which, in turn, results in a compression of the aorta. For its own part, this compression causes a circulatory disturbance in the vasa vasorum and a circulatory delay of the fluid of the interstitial tissue in the aortic wall. This causes a lack of nourishment to the vascular wall, predominantly affecting the muscle

layer. This lack of nourishment can lead to a necrosis of the lamina muscularis and thus result in the development of the aneurysm under the ligature.

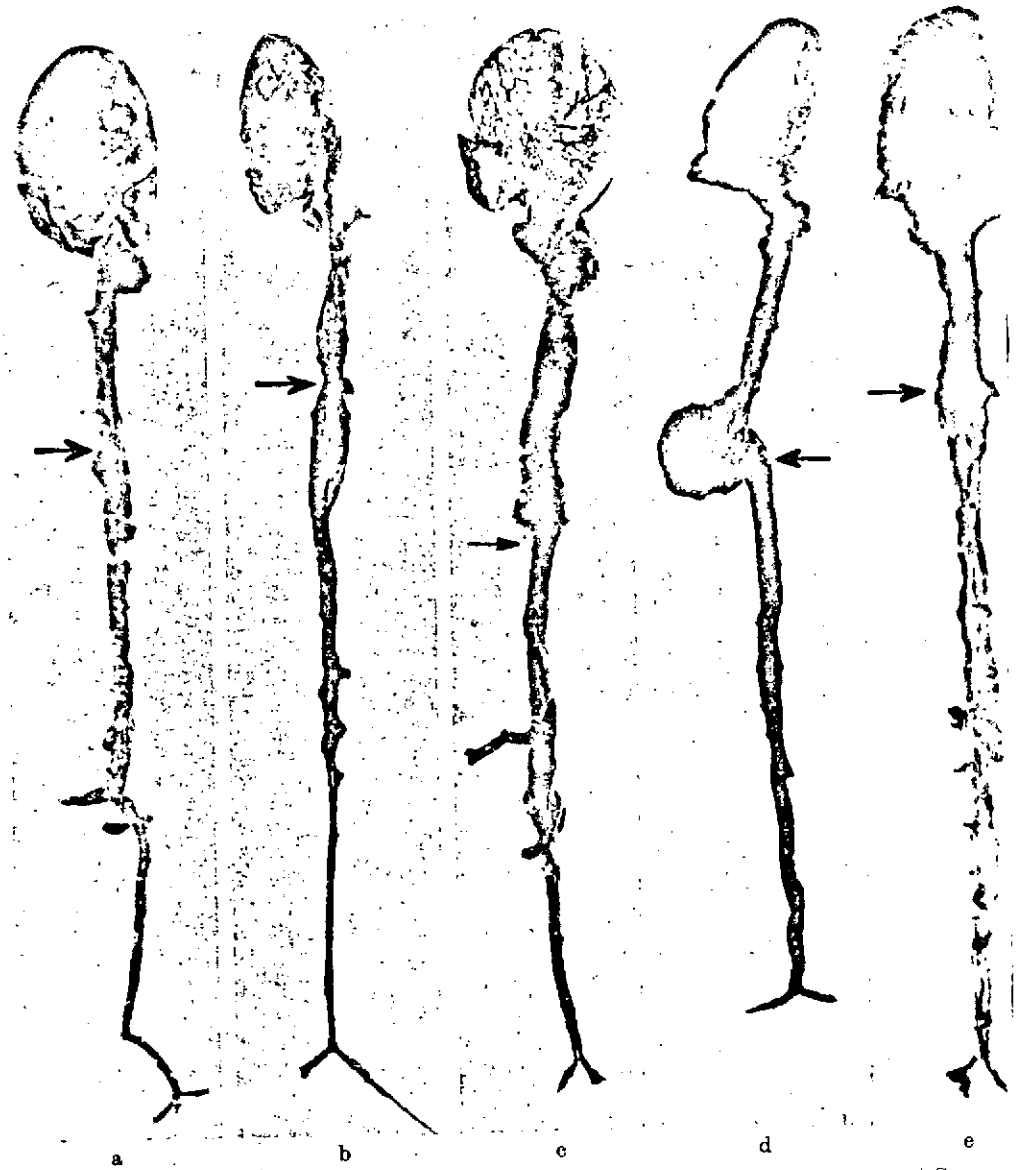

Figure 1a-e. Aorta and Heart of Experimental Rabbits.
a, Rabbit N 1 of the first group; b, Rabbit N 1 of the second group; c, Rabbit N 1 of the third group; d, Rabbit N 2 of the third group; e, Rabbit N 2 of the fifth group. Details are contained in the text and table. Arrows mark locations of the ligatures.

TABLE. CHANGES IN AORTIC AND ARTERIAL PRESSURE IN EXPERIMENTS

Grp. No.	Consec. No.	Degree of Aortic Constriction Through Ligature	Duration of Limitation of Movement of Rabbits	Total Length of Pause Between Limitation of Movement of the Rabbits	Degree of Limitation of Movement of Rabbits	Changes in the Aorta	Arterial Pressure mm Hg.S	Remarks
1	1	Does not press the aorta	30 days	6 days	Severe	Fusiform aneurysm under the ligature.	105	--
	2	"	"	5 days	Severe	" " "	103	--
2	1	Moderate constriction of aortic passage	30 days	6 days	Severe	2 pouchlike aneurysms (under and over the ligature)	118	--
	2	"	"	8 days	Severe	Fusiform aneurysm under the ligature	112	--
3	1	Significant constriction of aortic passage	30 days	8 days	Severe	2 aneurysms: pouch-like aneurysm over the ligature; diffused under the ligature	150	--
	2	"	10 days	--	Severe	Annular aneurysm over ligature with fissure	--	Died 10 days after beginning of limitation of movement
4	1	Moderate constriction of aortic passage	30 days	--	Moderate limitation situation is forced.	No aneurysm	118	--
	2	"	30 days	--	"	" "	130	--
	3	"	30 days	--	"	" "	116	--
5	1	Significant constriction of aortic passage	None	--		No aneurysm	128	--
	2	"	"			Insignificant expansion of the aorta over and under the ligature	175	--
	3	"	"	--		No aneurysm	140	--

FOLDOUT FRAME 1

FOLDOUT FRAME 2

In the case of the development of the aneurysm over the ligature, arterial blood pressure plays a leading role. All animals who developed an aneurysm over the ligature showed increased arterial blood pressure. The fact of autochthonic development of hypertonia through the partial aortic compression appears to us to be significant.

Consequently, the production of an aortic aneurysm in our rabbit experiments depends on two factors: 1) on the degree of limitation of movement; 2) on the degree of the aortic compression caused by the ligature. These factors should be considered together, however, since the experimental animals of the fourth group, with moderate limitation of movement and moderate compression of the aorta, did not form aneurysms, while those of the second group, with severe limitation of movement and moderate aortic compression did develop aneurysms. One should also consider, however, that a severe aortic compression without limitation of movement can produce an aortic aneurysm in a rabbit.

Translated for the National Aeronautics and Space Administration under contract No. NASw-2485 by Techtran Corporation, P. O. Box 729, Glen Burnie, Maryland, 21061. Translator: William Price.